

IMPROVE DUST CAPTURE ON YOUR SURFACE DRILL

BY STEVEN J. PAGE, JEFFREY M. LISTAK, AND RANDY REED



Figure 1: By measuring and monitoring leakage, mine operators can set benchmarks for reducing dust.

Researchers have developed a model to describe airborne respirable dust (ARD) generation on surface coal mine drills. By measuring a few basic parameters and using a graph, a drill operator or engineer can estimate the relative severity of drill dust emissions as well as how much of a reduction in ARD can be obtained by changing any given parameter.

Geometric parameters include: drill deck cross-sectional area, shroud leakage associated with the deck shroud as well as the operational parameters of bailing airflow, and dust collector airflow. The relationships yield predictive ARD values which fall in the range measured on operating drills for collector/bailing air flow ratios greater than 2.

Overexposure to airborne respirable crystalline silica dust can cause serious or fatal respiratory disease. Exposures of surface coal mine rock drillers to respirable crystalline silica are of particular concern. In a 1992 alert on silicosis in rock drillers, the National Institute for Occupational Safety and Health (NIOSH) reported on 23 cases of advanced silicosis (acute, accelerated, and chronic) ranging in ages from 25

to 60 with drilling tenures ranging between three and 20 years.¹ Most of the cases involved drill operators in their 30's and 40's, indicating high silica exposure levels are associated with their occupation. A more recent lung x-ray surveillance study of a 664 volunteer population of surface coal miners showed that the prevalence of silicosis-like abnormalities was 9%.² The two most significant factors associated with these abnormalities were increasing age and years of drilling experience.

The Mine Safety and Health Administration (MSHA) permissible dust exposure for coal mine workers is a shift average of 2 milligrams per cubic meter (mg/m^3) of airborne respirable coal mine dust, as defined by the British Medical Research Council (BMRC) Criterion.³ If the ARD sample contains more than 5% crystalline silica, the dust standard is reduced to the quotient of 10 divided by the percentage of silica in the dust, limiting the respirable crystalline silica exposure to 100 micrograms ($\mu\text{g}/\text{m}^3$, BMRC equivalent) for the working shift. Compliance with these respirable dust standards are expected to significantly

reduce a worker's risk to occupational lung disease throughout an average life expectancy.

A recent analysis of the MSHA data from 2000-2006 shows that the percentage of the DWP drill dust samples exceeding the permissible exposure limit has dropped to 16%, indicating that overexposure to silica dust is an ongoing surface coal mine dust problem for the highwall drill operator.

The Problem: Deck Shroud Dust Leakage

On surface coal mine drills, bailing airflow (Q_B) flushes the cuttings from the hole. The material is ejected from the hole at ground level with significant velocity. In an attempt to control/capture the respirable dust emitted from the hole, a deck shroud encloses the area around the drill deck and an external dust collector with air flow rate (Q_C) is used with the duct inlet typically located in the upper outboard rear corner of the enclosed deck volume. Frequently, the deck shroud is made merely by hanging four pieces of rubber belting from the deck. This obviously leaves gaps at the corner seams for dust to escape. Additionally, the shroud does not always reach the ground, leaving a gap around the bottom perimeter of the shroud where dust can escape. Dust leakage from the drill shroud was observed to be one of the worst dust emissions problems on many drills (Figure 1).

Solution: Drill Evaluation

Testing was performed on a full scale mockup, as previously reported in detail⁴, of a drill deck, deck shroud, drill pipe, and drill hole, enclosed within a large chamber. As a result, measurement of a few basic parameters can enable a drill operator or engineer to determine the relative severity of drill dust emis-

sions as well as how much of a reduction can be obtained by changing any given parameter. A ratio of $Q_C/Q_B = 3$ is usually the maximum design value found on drills with clean collector filters. However, the ratio of $Q_C/Q_B = 2$ is typically a much more common value found in actual operation for dust collectors with loaded filters that should be replaced. Ratios approaching $Q_C/Q_B = 1$ were worst-case test conditions and have been observed in actual drill operations.

For the ratio of $Q_C/Q_B = 2$, the amount of ARD can be estimated by measuring (1) the drill deck shroud cross-sectional area (A_S), (2) an approximate amount of shroud leakage area (A_L) or a range for the leakage area, and (3) Q_C and Q_B (known from the drill manufacturer). It should be noted that Q_C is perhaps the more difficult parameter to measure and that dust collector specifications should not be used since collector air flow specifications are made under ideal conditions with unloaded filters. Measurements of Q_C can be reasonably made by using a hot wire anemometer, vane anemometer, or pitot tube at the collector exhaust. However, more accurate measurements can be obtained by attaching a short (4 ft) duct extension to the collector exhaust. This extension can be simply made from cardboard and fitted to the outside of the collector exhaust duct.

To demonstrate the use of the graph, the following example is given: An operator

has a blasthole drill rig with drill deck dimensions of 4 ft x 5 ft. The rated compressor Q_B is 260 cfm and Q_C was measured at 530 cfm. Therefore, the ratio Q_C/Q_B is approximately 2, which allows the use of the graph in Figure 2. The area of the shroud is calculated by multiplying the width by the length resulting in $A_S = 20 \text{ ft}^2$. A_L is calculated by multiplying the leakage height (LH) in feet by the perimeter of the shroud which results in $A_L = LH \times 18 \text{ ft}$. Therefore, the ratio $A_S/A_L = 20 \text{ ft}^2 / (LH \times 18 \text{ ft})$ and can be calculated by estimating LH. It should be noted that any leakage area due to vertical shroud seam gaps must also be added, although this may not always be significant. Graphs for Q_C/Q_B greater than 2 are similar to Figure 2 with the difference being that ARD values at any value of A_S/A_L will become smaller as Q_C/Q_B increases.

Figure 2 shows how reducing the leakage gap between the shroud and the ground will reduce the severity of the dust concentrations. A gap of 14 inches corresponds to $A_S/A_L = 0.95$ showing a relative ARD concentration of approximately 16 mg/m^3 while a gap of 2 inches corresponds to $A_S/A_L = 6.7$ resulting in a relative ARD concentration of approximately 5 mg/m^3 .

However, it is important to keep in mind that the calculated value of ARD (a relative value only) is not as important as the estimated value of A_S/A_L . The important considerations are where on the curve does the drill operate, as determined by

A_S/A_L , and which curve is applicable (what value is Q_C). These determinations will indicate the long term average improvement that can be expected from either increasing the collector air flow (installing clean filters or a larger collector) or reducing the amount of shroud leakage. For example, a drill currently operating on the left side of the curves in Figure 2 can readily make significant ARD reductions. Operating on the right side of the curves indicate only minimal reductions are achievable. However, operation on the right side of the curves usually indicates a drill that has good operating dust controls. Typical values of Q_C/Q_B in actual operation with dirty filters are on the order of 2. At values of Q_C/Q_B approaching 1, the change in ARD shows minimal response, if any, to drill deck shroud improvements which do not result in near-zero leakage.

Author Information

Page, Listak, and Reed are researchers with the National Institute for Occupational Safety & Health.

References

- ¹ National Instituted for Occupational Safety and Health (NIOSH): *Request for Assistance in Preventing Silicosis and Deaths in Rock Drillers*. NIOSH ALERT, DHHS (NIOSH), Publication No. 92-107, 1992, 15 pp.
- ² Tyson, P.A., Stauffer, J.L., Mauger, E.A., Caulfield, J.E., Conrad, D.W. and Stricklin, K.G.: *Silicosis Screening in Surface Coal Miners - Pennsylvania, 1996-1997*. MMWR 49 (2000), pp. 612-615.
- ³ U.S. Code of Federal Regulations (1998): Title 30-Mineral Resources; Chapter I-Mine Safety and Health Administration, Dep. Labor; Subchapter O-Coal Mine Safety and Health, Part 70-Mandatory Health Standards-Underground Coal Mines, Subpart B, Section 70.101; and Part 71-Mandatory Health Standards-Surface Coal Mines and Surface Work Areas of Underground Coal Mines, Subpart B, Section 71.101. U.S. Gov. Printing Office, Office of Federal Regulations, 2001.
- ⁴ Page, S.J. and Organiscak, J.A.: *Semi-empirical Model for Predicting Surface Coal Mine Drill Respirable Dust Emissions*. *Int. J. Surface Min., Recl. And Env.* 1 (2004), pp. 42-59.

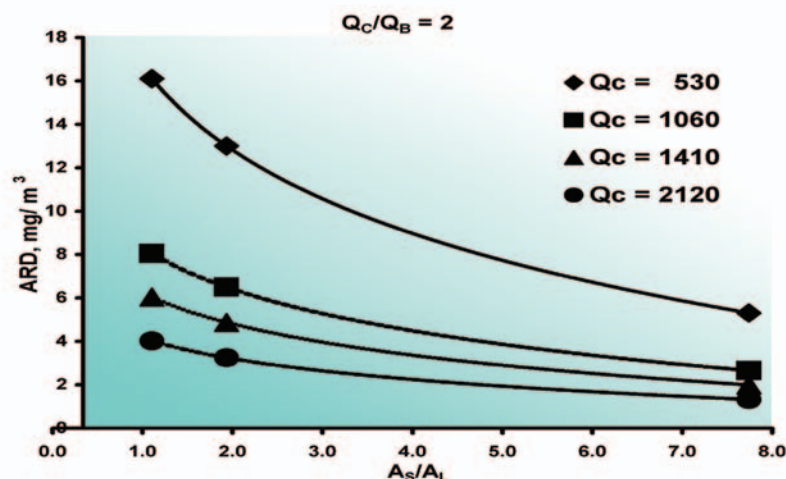


Figure 2: Predicted airborne respirable dust concentration vs. the deck area to shroud leakage area ratio for $Q_C/Q_B = 2$ and values of Q_C (ft^3/min).